

# **ALKYLATION CURRENT EVENTS**

**PRESENTED AT THE  
LAWRENCE LIVERMORE NATIONAL LABORATORY  
WORKSHOP ON ETHANOL & ALKYLATES IN FUELS**

**APRIL 10-11, 2001**

**Presented By:  
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# AGENDA

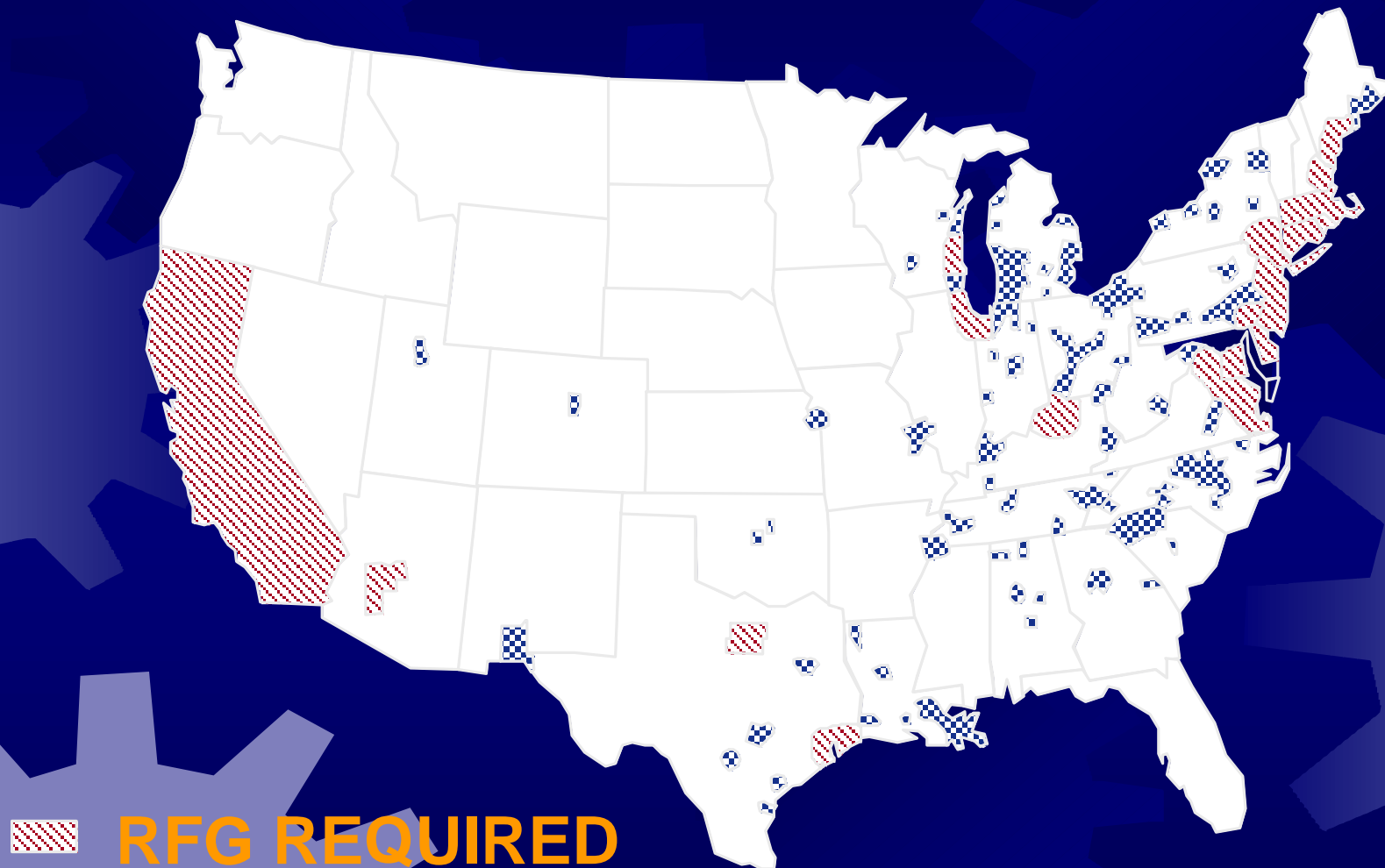
✍ REGULATORY/LEGISLATIVE ISSUES

✍ MTBE

✍ DRIVEABILITY INDEX

✍ ALKYLATE'S ROLE IN RFG

# U.S REFORMULATED GASOLINE



**RFG REQUIRED**



**NEEDS OZONE CONTROLS**

# RFG REQUIREMENTS

- U.S. NON-ATTAINMENT AREAS
  - PHASE 1 COMPLEX MODEL 1998-1999
  - PHASE 2 COMPLEX MODEL 2000+
- CALIFORNIA NON-ATTAINMENT AREAS
  - CA RFG PHASE 2 1996+
  - CA RFG PHASE 3 2003



# Ca RFG PHASE 2 & 3

## FUEL PARAMETER

## PHASE 2/3 ALLOWABLE LEVEL

SULFUR

40/20 WT PPM

AROMATICS

25/25 VOL%

BENZENE

1.0/0.8 VOL%

OLEFINS

6.0/6.0 VOL%

OXYGEN

2.0/2.0 WT%

T<sub>90</sub>

300°F (149°C)/305°F (152°C)

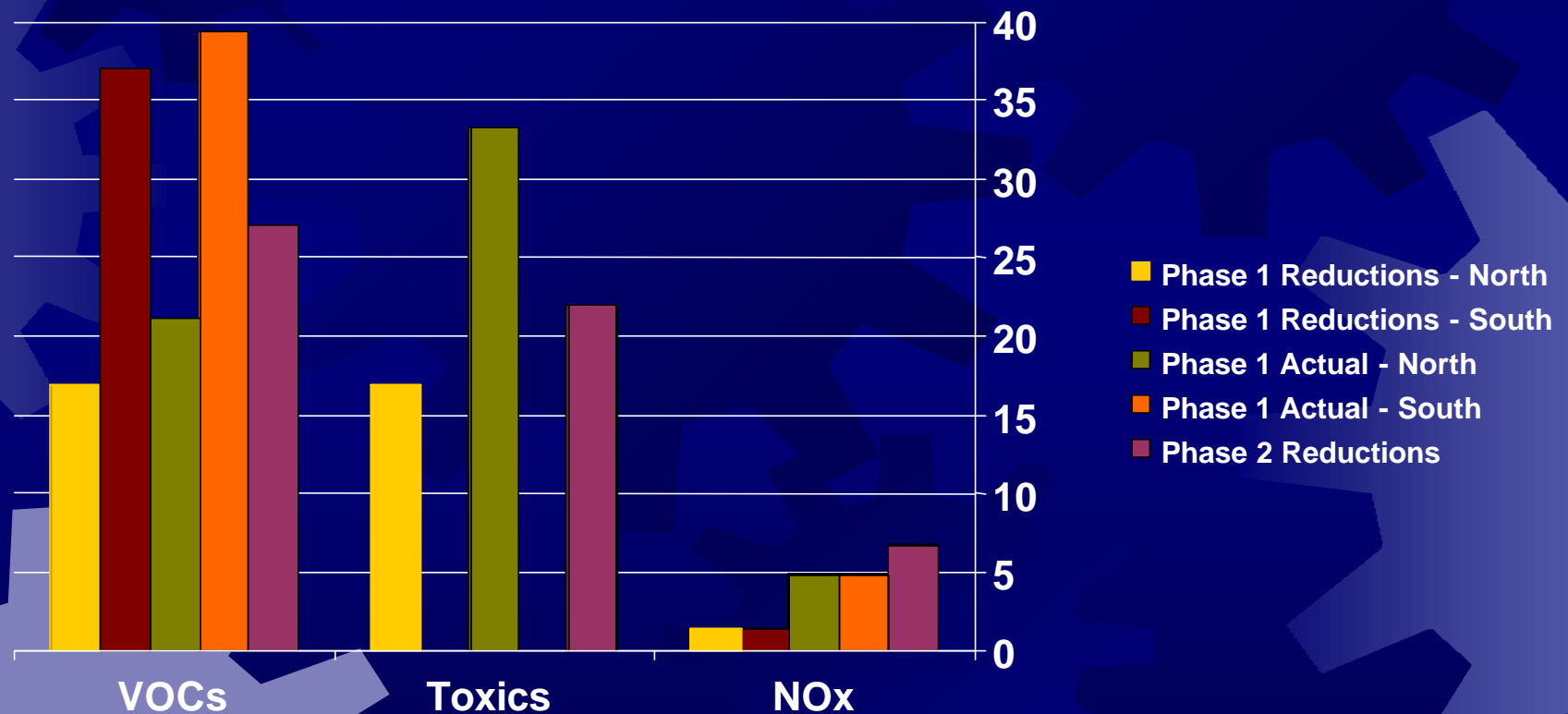
T<sub>50</sub>

210°F (99°C)/213°F (101°C)

RVP



7.0/7.0 PSI (0.49 KG/CM<sup>2</sup>)

# RFG PHASE 1 & 2 REDUCTIONS








# MTBE

## **FEDERAL OXYGEN MANDATE**

-  Over 18 bills introduced during 106<sup>th</sup> Congress.
-  May revert to a state by state decision.

## **OCTANE AND VOLUME LOSS HARD TO REPLACE**

## **ETHANOL**

-  If the oxygen mandate continues, ethanol is the most likely replacement.
-  Ethanol requires special handling considerations.
  -  To prevent groundwater contamination
  -  To offset NO<sub>x</sub> emissions according to CA Predictive Model
  -  Alkylate to balance ethanol's blending RVP

# DRIVEABILITY STANDARD

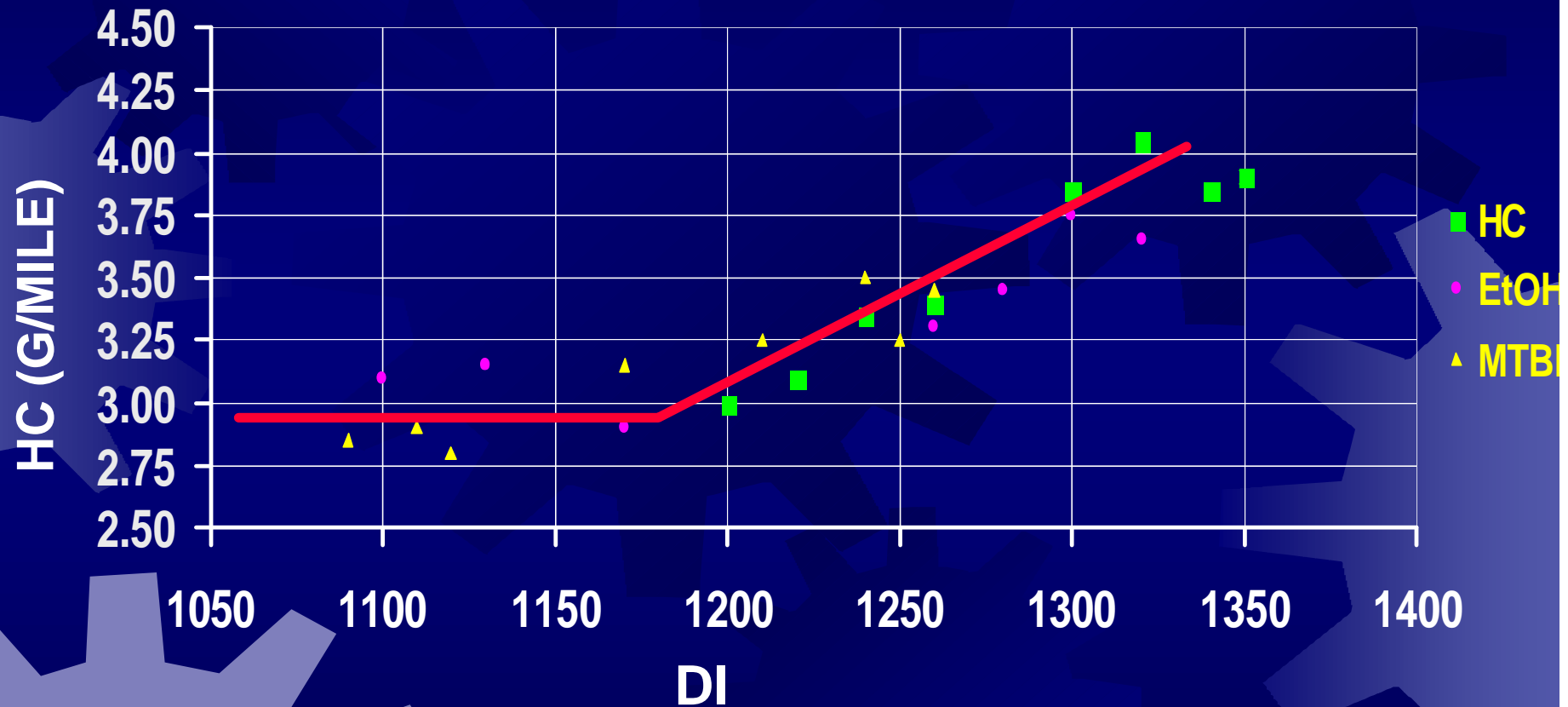
## DRIVEABILITY INDEX:

$$DI (^{\circ}F) = 1.5 (T_{10}) + 3(T_{50}) + T_{90} + (20 \times \text{wt\% Oxygen})$$

$T_{50} = 170 ^{\circ}F$  MINIMUM

$DI = 1200 ^{\circ}F$  MAXIMUM

# EMISSIONS vs. DI



Source: GM

# ALKYLATE'S ROLE IN RFG

 IDEAL BLENDSTOCK

 100% PARAFFINIC

 LOW RVP

 HIGH OCTANE

 GOOD DISTILLATION  
CHARACTERISTICS

 NO/LOW SULFUR

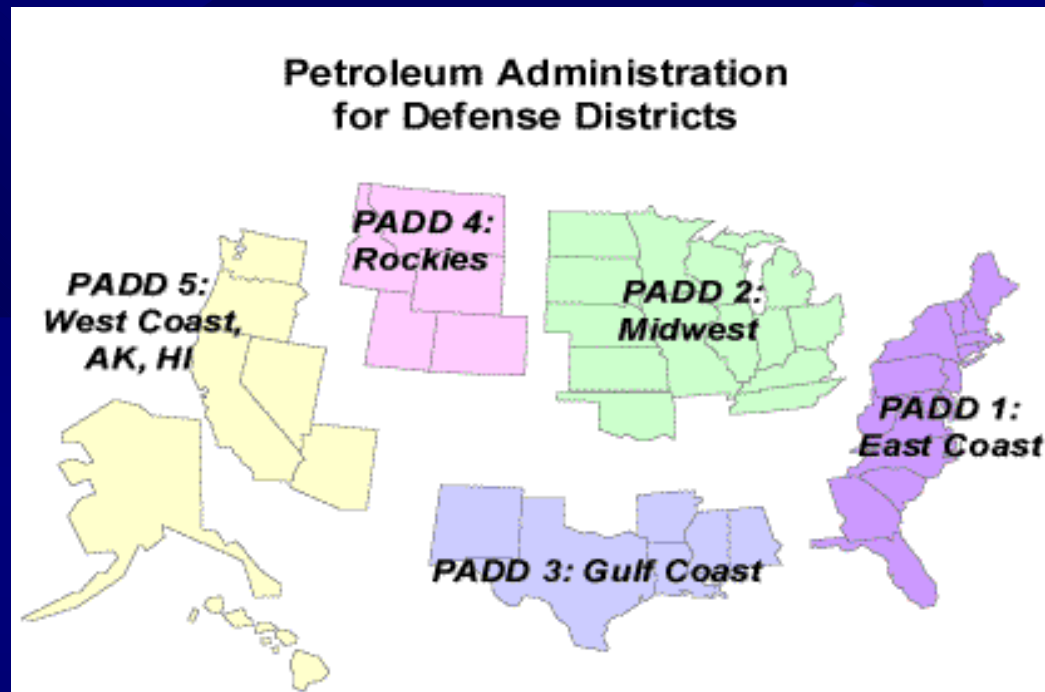
 DILUTION EFFECT

# GASOLINE BLENDSTOCKS

	ALKY	FCC	REFORMATE	POLY
AROMATICS	0	29	63	0
OLEFINS	0	29	1	95
SULFUR	~0	756	~0	~0
MON	92	81	87	82
RON	94	92	98	94
DI	1134	1223	1299	1251

SOURCE: NPRA

# RFG BLENDING PROPERTIES BY PADD



**PADD 5**  
FCC Gasoline-26%  
Reformate-23%  
Alkylate-15%  
Oxygenate-11%  
Hydrocrackate-10%

**ALKY CAPACITY**  
196,900 BPD

**PADD 2**  
FCC Gasoline-33%  
Reformate-29%  
Alkylate-12%  
Oxygenate-10%  
Hydrocrackate-3%

**ALKY CAPACITY**  
295,000 BPD

**PADD 1 & 3**  
FCC Gasoline-40%  
Reformate-25%  
Alkylate-11%  
Oxygenate-11%  
Hydrocrackate-3%

**ALKY CAPACITY**  
600,000 BPD



# ALKYLATION – PROVEN TECHNOLOGY

## NOT NEW TECHNOLOGY

-  Molecules in gasoline from beginning.

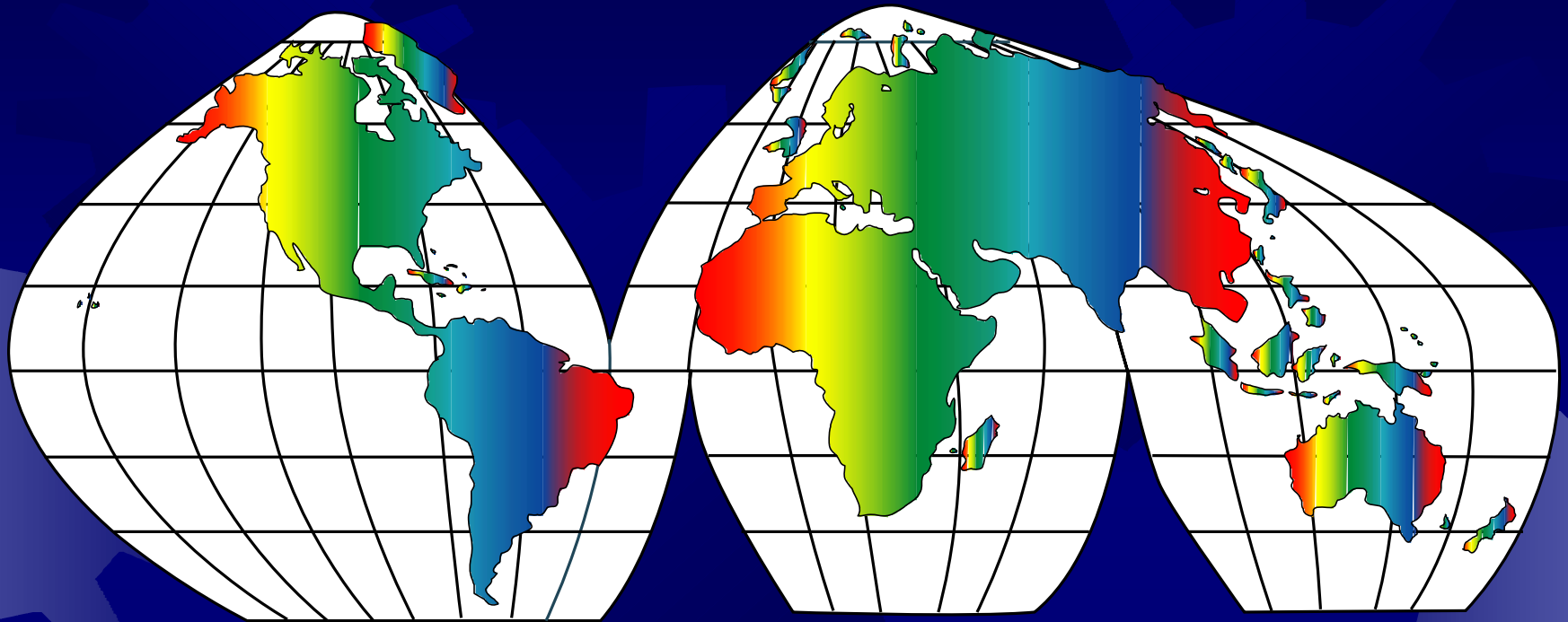
-  On-purpose production began in 1930's.

## ALKYLATE CURRENTLY ACCOUNTS FOR 15-30% OF THE FINISHED GASOLINE POOL.

## PERRY'S CHEMICAL ENGINEER'S HANDBOOK LISTS ALKYLATES MOLECULES AS INSOLUBLE IN WATER

# SUMMARY

- ✍ RFG LEGISLATION, MTBE PHASEOUT AND THE OXYGEN MANDATE UNCERTAINTY ARE MAJOR FACTORS INFLUENCING REFINING INDUSTRY.
- ✍ ALKYLATION GROWTH CONTINUES TO BE ENVIRONMENTALLY DRIVEN.
- ✍ TREMENDOUS SYNERGY BETWEEN ALKYLATE AND ETHANOL.



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